

(NASA-CR-178822) SPACE PLATFORM EXPENDABLES  
RESUPPLY CONCEPT DEFINITION STUDY. VOLUME 3:  
WORK BREAKDOWN STRUCTURE AND WORK BREAKDOWN  
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SPACE PLATFORM EXPENDABLES  
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STS 85-0174

Volume III

Work Breakdown Structure

And

Work Breakdown Structure Dictionary

Contract NAS8-35618

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## INTRODUCTION

This document contains the work breakdown structure (WBS) for the space Platform Expendables Resupply Concept Definition Study.

The WBS consists of a list of WBS elements, a dictionary of element definitions, and an element logic diagram. The list and logic diagram identify the interrelationships of the elements. The dictionary defines the types of work that may be represented by or be classified under each specific element.

The Space Platform Expendable Resupply WBS, as defined herein, was selected mainly to support the program planning, scheduling, and costing performed in the programmatic Task (Task 3).

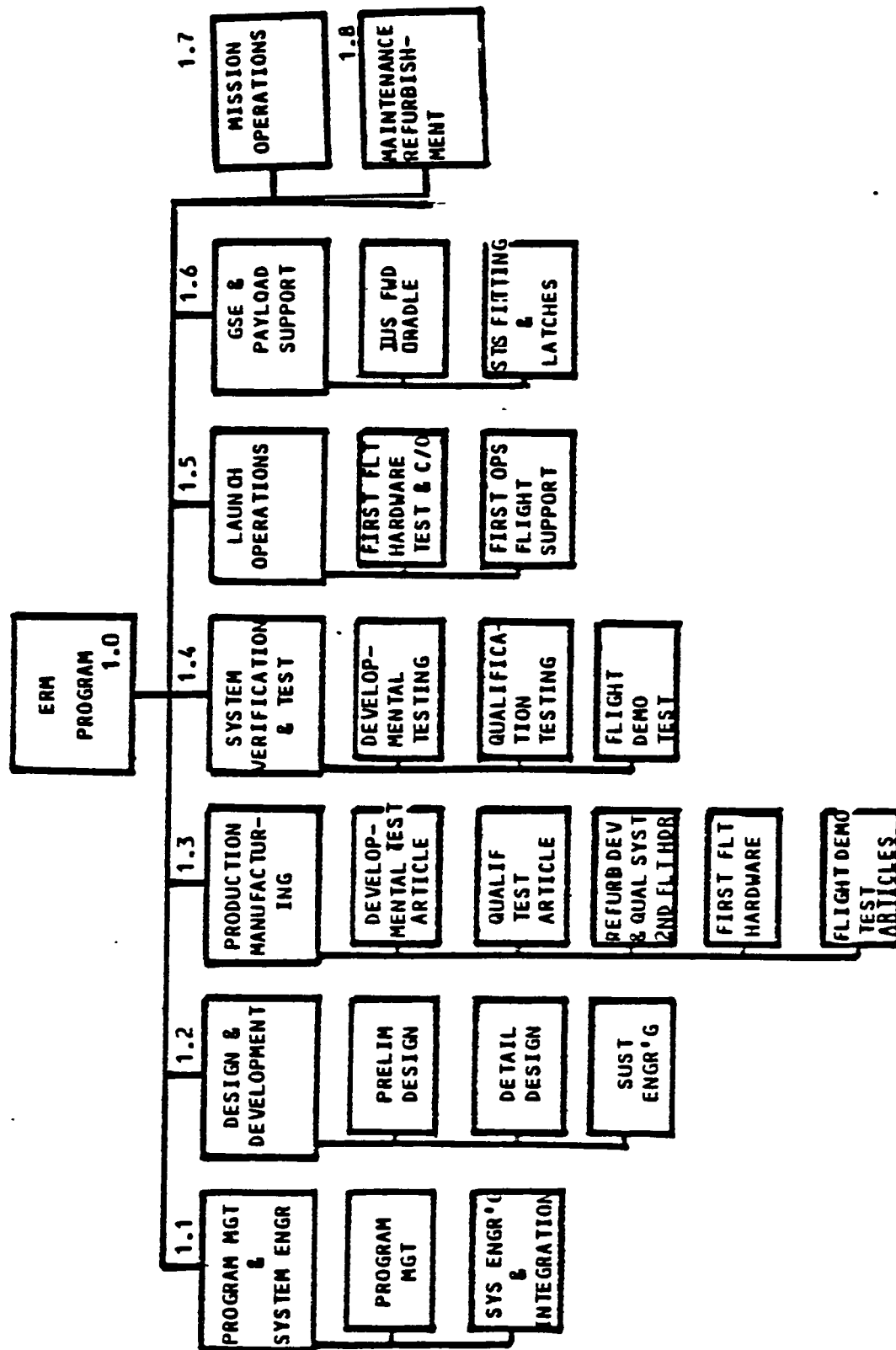
The WBS is neither a statement-of-work nor a work authorization document. Rather, it is a framework around which to define requirements, plan effort, assign responsibilities, allocate and control resources, and report progress, expenditures, technical performance, and schedule performance. The WBS element definitions are independent of make-or-buy decisions, organizational structure, and activity locations unless exceptions are specifically stated.

## WORK BREAKDOWN STRUCTURE FOR ERM PROGRAM

The selected work breakdown structure for the ERM program consists of the following elements:

- 1.1 Program management and system engineering is the core of the program and provides the overall program perspective necessary for continuity and decision-making.
- 1.2 Engineering design
- 1.3 Manufacturing, procurement of purchased systems and assembly of test articles and flight units.
- 1.4 Developmental, qualification, flight demonstration, and functional testing.
- 1.5 Mission planning, flight support, and check-out necessary to support the first launch and post-flight analysis.
- 1.6 Payload support for the resupply module in the orbiter payload bay is GFE (this hardware is available from other programs).
- 1.7 & 1.8 Operational support beyond the baseline program has not been costed.

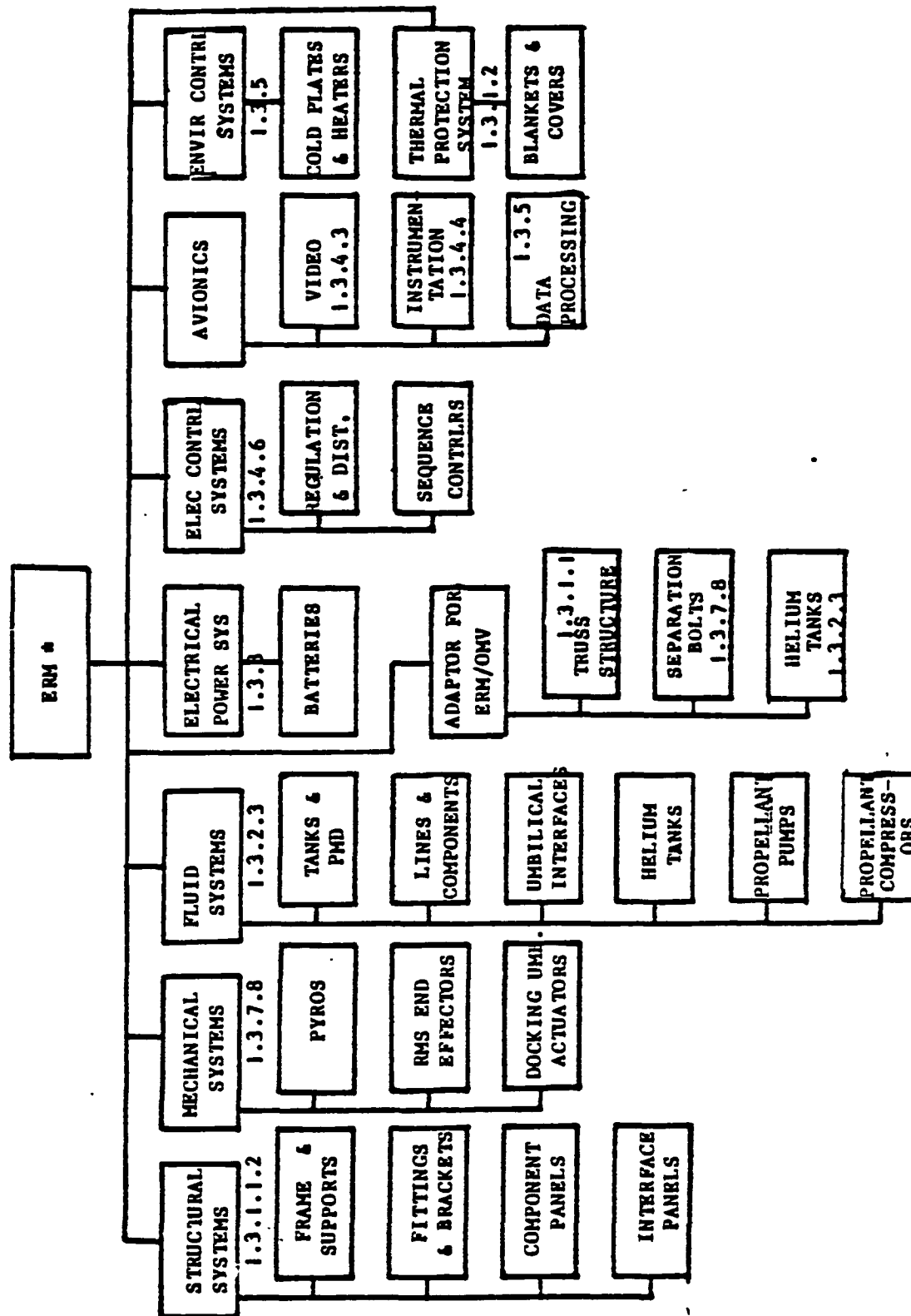
# WORK BREAKDOWN STRUCTURE FOR ERM PROGRAM



## ERM SYSTEMS WORK BREAKDOWN STRUCTURE

The WBS numbers used in the programmatic Task 3 Section are Orbiter/STS designations.

# ERM SUBSYSTEMS WORK BREAKDOWN STRUCTURE



\*ORBITER/STS WBS DESIGNATIONS



#### ERM SYSTEM WEIGHTS

The weights range for each ERM System reflects on 80 percent confidence that the actual design weight will be between a low of 8260 and a high of 9170 pounds.

# ERM SYST WEIGHTS

ORB/STS	COMPONENT	QTY	CLASS	STS COST BASE	WEIGHT-LB	ORB/STS	COMPONENT	QTY	CLASS	STS COST BASE	WEIGHT-LB
1.3.1.2	BODY STRUCTURE • FRAME & SUPTS • FITTINGS & BRKTS • COMPONENT PANELS • INTERFACE PANELS	1	NEW	MID FUS STRUCT	(2536)(2784) 1644 1808	1.3.3	ELEC. POWER • BATTERIES (44KW/Hr)	-	-	-	( 800)( 960)
1.3.1.2	IPS • BLANKETS & COVERS	172	"	"	182 200	1.3.4.6	ELEC. POWER DIST & CNIL • REG. & DIST • SEQ. & CNIL	-	MOD	-	( 360)( 504)
1.3.1.2	SEPARATION MECHANISMS • PYRO'S • RMS END EFFECTORS • DOKING • UMB. ACT'S	20	"	"	560 616			-	NEW	EDPC	280
1.3.1.2	FLUID SYS. • TANKS & PMD • LINES & COMPONENT	2	"	"	150 165			-	NEW	EDPC	160 224
1.3.1.2	UMB. INTERFACE • HELIUM TANKS • PROP PUMP & COMPRES	12	NEW	"	977 992	1.3.4.3	AVIONICS • VIDEO • INSTRUMENTATION • DATA PROCESSING	-	MOD	CNTLS & DISPLAY	( 291)( 407)
1.3.2.3	FLUID SYS. • TANKS & PMD • LINES & COMPONENT	12	NEW	"	977 992			-	MOD	INSTRUMENTATION	100 140
1.3.2.3	UMB. INTERFACE • HELIUM TANKS • PROP PUMP & COMPRES	12	NEW	"	977 992			-	NEW	DPS	125 175
1.3.2.3	FLUID SYS. • TANKS & PMD • LINES & COMPONENT	12	NEW	"	977 992	1.3.5	ENVIRON. CNIL SYSIEH • COLD PLATE & HEATERS	-	-	-	( 100)( 120)
1.3.2.3	UMB. INTERFACE • HELIUM TANKS • PROP PUMP & COMPRES	12	NEW	"	977 992			-	MOD	EC/LSS	100 120
1.3.2.3	FLUID SYS. • TANKS & PMD • LINES & COMPONENT	12	NEW	"	977 992			-	-	-	8259 9168

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## DICTIONARY

### 1.0 SPACE PLATFORM EXPENDABLES RESUPPLY MODULE

This element encompasses tasks associated with development, production and support of the Expendables Resupply Module. The tasks include system design, fabrication, assembly, installation and checkout, and quality control; engineering studies and testing; support equipment; tooling; procurement activities; facility activation; system interface definition; control and integration of government-furnished equipment (GFE) into the spares provisioning; operations support; and requisite program management activities.

#### 1.1 PROGRAM MANAGEMENT & SYSTEM ENGINEERING

This element contains tasks associated with management and support of the Expendables Resupply Module. The tasks include planning, organizing, and defining requirements; establishing schedules and allocating resources to attain objectives; reporting progress and providing program status visibility; and controlling the program activities.

This element also defines requirements for the design, development, production, and test of the Expendables Resupply Module, including analyses that support the development of designs and verify compatibility of designs with requirements and tasks required to control and direct engineering activities related to the design of the system.

#### 1.2 FLIGHT HARDWARE DESIGN, DEVELOPMENT, AND QUALIFICATION

This element includes detailed design of structures, system components, interface hardware, testing, evaluation, and utilization of test results to finalize ERM production designs. Work effort includes inspection, procurement, and support to safety and reliability.

This element is subdivided into the following Level 7 elements:

- Structural Systems
- Mechanical Systems
- Fluid Systems
- Electrical Power Systems
- Electrical Control Systems
- Avionics
- Environmental Control Systems

### 1.3 PRODUCTION/MANUFACTURING

This element includes all design, manufacture, inspection, and acceptance test activities that are unique to the production of specific flight units of the Expendables Resupply Module. Included are the manufacturing and assembly of the developmental test article, the qualification test article, the first flight units, and the refurbishment systems salvaged from the developmental and qualification test articles, and assembly into a second flight unit.

#### 1.3.1.1.2 STRUCTURES

This element includes design, development, and qualification of structural components for the expendable fluid resupply, including primary and secondary structures and thermal protection items for structures.

#### 1.3.1.1 ADAPTOR FOR ERM/OMV

This element includes the design, development, and qualification of truss structure between the ERM and OMV for attachment of robotics for spacecraft servicing, separation bolts, and helium tanks.

#### 1.3.2.3 FLUID SYSTEM

This element includes design, development, and qualification of propellant storage and transfer components, including fluid lines, umbilical interfaces, helium tanks, propellant pumps, compressors, disconnects, valves, tanks, and component thermal protection items. Also included are assembly and testing of the complete fluid system.

#### 1.3.3 ELECTRICAL POWER SYSTEM

This element includes the design, development, and qualification of 44KW/Hr. rated batteries.

#### 1.3.4 AVIONICS SYSTEM

This element includes design, development, and qualification of instrumentation, displays, controls, data processing, and electrical distribution and control components of the system. Also included are assembly and testing of the complete avionics system.

#### 1.3.4.6 ELECTRICAL CONTROL SYSTEM

This element includes the design, development, and qualification of electrical regulation and distribution subsystems and actuation sequence controllers.

### 1.3.5 ENVIRONMENTAL CONTROL SYSTEMS

This element includes the design, development, and qualification of cold plates and heaters, thermal protection systems, and blankets and covers.

### 1.3.7.8 MECHANICAL SYSTEM

This element includes design, development, and qualification of RMS end effectors, docking umbilical actuators, and pyros.

## 1.4 SYSTEM VERIFICATION AND TEST

This element contains the task of verifying the expendable resupply module concept with two test articles: developmental and qualification. The developmental test article will be tested first at the White Sands Test Range to verify fluid transfer, docking and release, pressurant transfer, and tankage monitoring capability. In addition, the ERM will be fit tested to the orbiter and the OMV to verify their compatibility.

The qualification test article will be tested first at Johnson Space Center for acoustic vibrations, thermal vacuum and random vibrations. Then, the qualification test article will be shipped to White Sands Test Facility for fluid transfer tests beyond the ERM's design limits.

## 1.5 LAUNCH OPERATIONS

This element includes the test and checkout of the first flight unit prior to launch, mission planning, operations support, and post-flight analysis of the first operational flight.

## 1.6 GSE & PAYLOAD SUPPORT

This element includes government supplied equipment such as the IUS forward cradle, STS fitting, and latches. The cost of these elements are not included in the baseline program cost estimate.

## 1.7 MISSION OPERATIONS

This element includes the mission support for managing the day-by-day operations of the expendable resupply module. This cost is not included in the baseline program cost estimate.

## 1.8 MAINTENANCE AND REFURBISHMENT

This element includes the logistic support for repairing and refurbishing the expendable resupply modules as required. This cost is not included in the baseline program cost estimate.